Establishment of Aesthetic Design for Smart Highway

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ABSTRACT

As enhancing the quality of life for better environment, people are getting interested in the field of landscape and aesthetics. So it is very important to promote aesthetic road designs for their desires.

This study presents the concepts and the scopes of the aesthetic road designs in detail and proposed a plan to establish the aesthetic roads. Particularly, this study focused on items which are relevant to the aesthetic road design in the project of 'SMART Highway'.

1. INTRODUCTION

As the quality of life has improved in the 21st century, road design should be needed a new paradigm shift from current functional road design to the safety and user-oriented road design as well as the pleasant and aesthetics-oriented road concepts. Also, roads should be well-designed for road users to walk/drive around with a good amenity.

In Korea, the concept of skill for the aesthetic road design hasn't been applied to general road design yet, only limited designs are available to several bridge structures and tunnel portals. Beside, though the necessities of urban public design have been emphasized on, its present state stays at the level of its decoration with the street furniture and the artifacts (sculptures, monuments and so on). But the most problem is that the concepts of the public design and the aesthetic road design have been mixed up without discretion.

This study is intended to establish and suggest the concept and range of aesthetic road design in more details so as to develop aesthetic road, especially focusing on aesthetic road design in SMART Highway that pursues the high-speed intelligent highway.

2. LITERATURE REVIEW

2.1 CONCEPT OF AESTHETIC ROAD

Definition of 'Aesthetic Road' is an interaction that happens between the on-looker and the object on the road. However, this relationship has to bring a positive affects to the road users. Aesthetic road can be divided into categories as seen in table 1.

<Table 1> Classification of Aesthetic Road

Broad Classification	Mid-Classification	Sub-Classification
Scenery On the Road	Scene	· Scenery that pedestrians look at on the sidewalk
	Sequence	· Scenery that road users look at on the road while driving
Scenery Off the Road	Scene	· Scenery that residents look at off the road

<Table 2> Constituent Elements of Aesthetic Road

Constituent Elements		Main Elements
Road Elements	Main roads	·Road Geometrics, Composition of transverse planes, road structures (bridge, tunnel etc.)
	Miscellaneous facilities	·Guard rail, Road lighting, Road signs, Traffic safety signs, Road side foliage (tree, flower etc.)
	Road side objects	·Electric poles, Advertising boards, Vents opening (subway etc.), Electric control boxes, etc.
Border Elements	Surrounding facilities	·Gas stations, Rest areas, Bus stops ·Shopping mall, Residential housing, Factories, Automobile related facilities ·Rice paddies, Farms, Streams, Landscape facility
Distant View Elements	Natural elements	·Mountains, Streams, Lakes, Coasts, Forests, etc.
	Artificial elements	·Long span bridges, Tunnel portal, Steel towers, Large structures, High voltage line

2.2 PUBLIC DESIGN OF URBAN AREA

'Public Design' means the behavior of enhancing aesthetic, symbolic and functional values of space, facility, supplies and information which public institute forms, produces, installs, operates and manages and its subsequent results. All the facilities easily accessed from simple urban daily life such as sign board and traffic light at the road, advertising board of building and so on.

<Table 3> Constituent Elements of Public Design for Road

Constituent Elements		Main Elements
Environmental Facilities		·Architecture, Parks, Promenade, Stream, etc.
Road facilities	Facilities for human	·Traffic signs, Bulletin boards, Advertisements, Newspaper booth ·Buses, Taxis, Bus Stops, Entrances of subways ·Public restrooms, Public telephone booths, Benches, Street light, Flower pots, Tree lines, etc. ·Garbage cans, Ash trays, Vending machines, Mail boxes
	Facilities for automobiles	·Traffic light, Traffic sign, Parking meter · Road safety facilities (such as Guard rails, etc.) ·Traffic control towers, etc.
	Miscellaneous	·Cable, Exhaust towers, Fire hydrants, etc.

2.3 AESTHETICS OF SMART HIGHWAY

'SMART Highway' means intelligence type express highway allowing design speed at 120km/h (initially set to 160km/h). On this highway the advanced IT, motorcar and road technologies are mutually incorporated.

In SMART Highway, the field of vision becomes narrower as it reaches the design speed at 120km/h, and the available speed at 140km/h. In addition, the subject of distant landscape is observed. Therefore it is necessary to attempt bold development focusing on the maintenance of street landscape. On the other hand, a delicate maintenance is required for the landscape at the static point. It must be noted that even if the viewing angle is narrow the subject of landscape nearby is finely recognized as it is. Accordingly it requires careful maintenance for the subject of landscape nearby.

Therefore, the study on the landscape of SMART Highway is considering the optimum aesthetic road by reflecting the pleasure in the design of overall SMART Highway aesthetic elements to the maximum.

3. MAIN CONSIDERATION AND THE METHOD OF TECHNICAL DEVELOPMENT OF SMART HIGHWAY AESTHETIC DESIGN

3.1 MAIN CONSIDERATION OF AESTHETIC DESIGN

SMART Highway aesthetic plan and design are intended to observe the followings as the basic principle.

- Reflecting the nature (characteristic) of the targeted road: Reviewing the landscape can be formed enough for the nature of the road and the characteristic of driver considering the correlation between natural and artificial aesthetic elements that are shown at high-speed driving.
- Aesthetic design for road users and residents: large-size structure exposed to the outside can be constructed as it requires aesthetic design for a variety of road users such as driver who runs at high speed.
- The style with total balance: In the structures such as upper/lower types of bridge, retaining wall, etc. or the cross-sectional construction of the road, it requires securing structural safety and traffic safety, and simultaneously enhancing the road landscape by considering the entire balance and continuity of the route.
- Unification and Change: Road aesthetics should be the one that accomplish balance with several facilities at the border and the inside of road site as well.
- Aesthetic changing with the time elapse: The landscape normally changes depending on the lapse of time, weather and season, and as time passes by, the aesthetic may change by the materials getting deteriorated and the plants growing higher. Therefore, it requires change and growth of the landscape caused by natural factors and natural power.
- Relationship with regional landscape and creation of new landscape and so on: It requires minimization of landscape destruction, harmony between artificial structure and regional environment as well as environmental protection in case of aesthetic road design and maintenance.

3.2 METHOD OF DEVELOPING AESTHETIC DESIGN TECHNOLOGY

The following items should be considered to develop SMART Highway aesthetic design technology.

- Study on the basic method of SMART Highway aesthetic design: Landscape characteristic analysis and aesthetic element required to be considered when planning SMART Highway aesthetics so as to enable to conduct in-depth research.
- Establishment of SMART Highway Aesthetic Design Methodology: Research data and standards at home and abroad related with aesthetic road to be reviewed and analyzed, the subject range of SMART Highway aesthetic design to be set up, and the aesthetic design procedure to be prepared in consideration of design element.

- Build-up of Main Road Aesthetic Design System on SMART Highway: It is necessary to study on the aesthetic design method related with the geometric alignment and cross sectional area, aesthetic design method related with three-dimensional alignment and harmony with surrounding area and so on.
- Construction of SMART Highway Attached Facility and Structure Aesthetic Design System: road attached facility and road structure aesthetic designs must be kept in good scenery and in harmony with the surrounding landscape, enabling the drivers feel the change of season, the aesthetic of which can be improved as time goes by.
- Construction of Surrounding Facility of SMART Highway Aesthetic Design System: Basic aesthetic design system to be conducted related with the location and layout of the rest area and tollgate.

3.3 DIRECTION OF DEVELOPING AND PROMOTING AESTHETIC DESIGN TECHNOLOGY

Following considerations are required to promote the aesthetic design technology.

- Correlation with the other technology development research: SMART Highway landscape is primarily related with the geometric, sectional constituent element, facility element, etc. that constitutes the main road, and therefore it is necessary to review the linkage with the other tasks examining such standards.
- Build-up and utilization of aesthetic design specialist DB: It is essential to invite the specialists from various fields in order to build safe, pleasant, road-user oriented and environment-friendly roads. To carry out the aesthetic design in the construction of future-oriented road, it is necessary to include external landscape as well as internal landscape that are the major concern of driving landscape, and the cooperation of the specialists from various fields as well. It is necessary to build up and use the specialist DB system that can be linked when necessary with the present status of them updated at real time basis.
- Preparation and utilization of SMART Highway aesthetic design guide: In order to have SMART Highway aesthetic design, it is necessary to prepare the guide that can be applied to the design work. In this task, ‘(tentatively named) SMART Highway Aesthetic Design Manual’ should be published based on the result of previous studies so that it can be applied to the actual work
- Development of aesthetic assessment tool: Securing the pleasure and the sense of landscape of the road following the improvement of the quality of life are the essential elements to be considered in the road design.

4. ESTABLISHMENT OF THE ELEMENTS AND BASIC PRINCIPLE FOR SMART HIGHWAY AESTHETIC DESIGN

4.1 ESTABLISHMENT OF AESTHETIC ROAD-RELATED ELEMENTS

Relevant guideline of each country was examined to review the aesthetic road design element;

(1) Motorway Landscape Plan

As the road structure or road space tends to be in larger scale, its influence on the border environment appears to be in diverse type and large volume. In this regard, a variety of fields and range in the landscape plan related with the motorway including the high standard highway in general were discussed.

(2) Aesthetic Design Guidelines

The guideline was established to provide direction, education and support of Ohio Traffic System, which considered consistent aesthetic element in the transportation project development on the appearance and type well-arranged in consistent manner, color, construction, structure, sculpture and so on.

(3) Landscape and Aesthetics Design Manual

This describes the information on the road landscape and aesthetic design, covering the procedure of conducting from assessment to plan and design stages.

(4) Guidelines for Highway Landscaping

This states the details about highway landscape in general. Especially, it includes safety maintenance and enhancement of highway, enhancement of the diversity of living creatures, improvement of visual quality, management of runoff, vermin management, contribution to the reduction of greenhouse gas emission, enhancement of conducting the projects, etc.

As a result of reviewing the literature, traffic advanced countries are reported to exert efforts to derive the abundant design method in terms of aesthetic and landscape under high-speed driving condition through the relevant guideline, etc. Even the aesthetic design is not the extraordinary subject to be considered, but is deemed to be considered fundamentally from the design stage. Especially, the guideline in part describes the details about overall landscaping, where a number of implications are cast from the techniques like safe maintenance of highway and harmony between surrounding environment and plants, design build-up, etc.

The aesthetic design elements for SMART Highway in consideration of comparison/review of these standards and domestic circumstances can be established as Table 4.

<Table 4> SMART Highway Aesthtic Design Elements

Chapter 1 General

Chapter 2 Aesthetic Design in General

2.1 Concept of Aesthetics and Landscape

2.2 Procedure of Aesthetic Plan and Design

Chapter 3 Aesthetic Design

3.1 Design of the Aesthetic for Main Road and Facility

1) Alignment design

(1) Horizontal Alignment

(2) Vertical Alignment

(3) Cross Section

(4) Three-dimensional Alignment

2) Intersection Design

(1) Interchange

(2) At-grade Intersection

3) Slope Landscape Design

4) Bridge / Elevated structures

5) Tunnel

6) Roadside Facility Aesthetic Design

(1) Rest Area

(2) Tollgate

3.2 Aesthetic Design of Road-affiliated Facilities

1) Affiliated Facilities

(1) Safety Barrier

(2) Traffic Safety Signs

(3) Delineator

(4) Median Strip

2) Sound-proof Facility

3) Green Space Formation

4) Sculptures

Chapter 4 Other Considerations

1) Safety

2) Public Involvements

3) Value of Aesthetics

4.2 ESTABLISHMENT OF THE BASIC PRINCIPLE OF SMART HIGHWAY AESTHETICS

(1) Main Road (Alignment Design)

- The main road may terminate natural landscape or damage the landscape resource, and therefore it requires sufficient consideration in advance.
- It is important to emphasize alignment beauty by showing smooth and affordable alignment considering marginal Clothoid curve.
- Large-scale cutting slope is the method of implementing the horizontal alignment toward the lower side of the natural feature, but the method of elevating the vertical alignment can be taken into account. It is also important to reduce the area of embank slope that modifies the nature as well as the relation with cutting slope.
- Besides, the task to be reviewed includes keeping out of the road-affiliated facilities considered to be problem in terms of aesthetic, and the change of the horizontal alignment to avoid the installation of sound-proof wall could be reviewed too. Therefore, it is also possible to use natural feature or planting that may be useful for sound-proof effect.

(2) Road facilities

A. Slope

- The review of slope in terms of landscape is intended to avoid/reduce the appearance of cutting slope, reduce the surrounding concrete treatment, shield/landscape the concrete-treated slope, landscape the planted slope , maintain the driving environment accomplishing the harmony with the surrounding landscape.
- It is desirable to have the measure for the aesthetic of the slope itself, landscaping of the tree-planting slope and the greening method of coping with the area other than slope after the phase of final structure being fixed through the review selecting route, road construction, alignment setup and road structure.

B. Bridge/Elevated structures

- The review of bridge/elevated structures in terms of aesthetic is intended to address the prohibition of the modification of natural, natural restoration, harmony with regional landscape, fine beauty of bridge/elevated structures themselves in terms of landscape, and the aesthetic of bridge/elevated structures. It is necessary to restore the nature around bridge/elevated structures installed in the natural area and prohibit the modification of the nature. It is essential to have the installed bridge/elevated structures kept in harmony with the regional landscape.

C. Tunnel

- Inside of the tunnel is narrow and dark space having the sense of pressure being closed extremely and therefore the drivers may feel mental pain when they drive it through. Especially, it requires reviewing the aesthetic in such a manner of relieving them the mental tension caused from high-speed driving. Therefore, it is necessary to install bright lights considering the contrast adaptability, treat beautiful scenery inside the tunnel or enlarge the cross section.

D. Sound-proof wall

- The procedure of reviewing the sound-proof wall in terms of aesthetic starts from removal of sound-proof wall. For this, it requires reviewing the route selection or line form design that doesn't require the sound-proof wall, and considering the procurement of buffer zone that has some interval between the road and the subject matter, and lastly the road structure replacing the sound-proof wall should be thought.

5. CONCLUSION

The concept of aesthetic road has been newly born since the 20th century as a field of what we call landscape engineering. In particular, it took place subsequently from expressway such as exclusive motorway. In the past, there already existed aesthetic road in the passive concept of scenery and view seen from the road. But they were only the subject matter appreciated given from the nature. The expressway – if it is exclusive motorway in modern times - requires sound horizontal alignment

and vertical alignment in its nature of function, which is difficult to be familiar with the natural feature and accompanying the large-scale improvement. Therefore it gave great visual influence on the natural/life environments of the border as well as the natural landscape.

Accordingly, the aesthetic plan and design are required to utilize a variety of amenity resources such as environment, landscape, history, culture, etc, from the design stage. It also requires unique and attractive highway in harmony with surrounding landscape and aesthetic beauty.

This study aimed at concrete materialization of concept and range for aesthetic road as they are not made clear yet in previous studies. And major consideration and method of technical development for aesthetic road design in SMART Highway were also suggested. In addition, the design elements of SMART Highway were derived through by perusing relevant guidelines of each country. As the next step, further study could address design technique on the aesthetic elements of SMART Highway main road and related facilities associated with relevant standard and design manual. This will enable to provide the road in pleasant and safe environment to the road users.

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